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CONTENTS

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EDWARD CHARLES PICKERING

BY the death of Edward C. Pickering American science has lost one of its most distinguished figures, one of the most noteworthy contributors to its progress during the past forty years, and one of its most inspiring and influential leaders. A full account of his long and active career would demand far more space for its presentation and time for its preparation than are at the moment available; only the main events and achievements of an exceptionally productive life can be touched upon in these few words of appreciation.

Born at Boston, in 1846, of an old New England family, and a graduate of Harvard of the class of 1865, after two years as instructor in mathematics, he became professor of physics at the Massachusetts Institute of Technology, where he established the first laboratory in America in which students were instructed by actual contact with physical instruments and measurements. Upon the death of Professor Winlock, the youngest physicist was called, in 1877, at the age of thirty-one, to the directorship of the Harvard College Observatory, which he held for nearly forty-two years, continuing the tradition of the institution, all of whose directors have died in office.

At this time most observatories were devoting themselves mainly to the old "astronomy of position"—the determination of the apparent positions of the stars and other heavenly bodies upon the celestial sphere, and of those constants of nature which can be derived from such observations—and the "new astronomy" (now bet-

ter known as astrophysics) was in its infancy. It is characteristic cf Pickering that he realized at once in what direction the greatest opportunities lay, and set to work to employ the full resources of the observatory in fundamentally important work. Harvard had always been sympathetically inclined towards the newer developments of astronomical science, and considerable photometric work had been done under Bond and Winlock; but, when the new director began to devote the main portion of his own time, and that of the fifteen-inch telescope (then one of the greatest in the country) to photometric researches, considerable criticism was aroused. "Why," said these critics, "should observations with the meridian circle and micrometer, which yield results accurate almost to one part in a million, be neglected in favor of measures in which differences of five, or even ten per cent. habitually occur? Can such inaccurate observations be of any value in an exact science?"

Undaunted by these cavils, he continued in his chosen course—with what abundant reason the nearly eighty volumes of the "Harvard Annals" which appeared during his directorate may testify. The "old astronomy" was not neglected—in fact, twenty years' time was spent by several members of the staff in preparing each of the two Harvard zones of the Astronomische Gesellschaft's scheme of international cooperation in star-cataloguing—but the astrophysical work accomplished under Pickering's directorship, and bearing the marks of his genius, is of incomparably greater volume and importance. He was a pioneer in several fields, in each of which he has had many followers.

He was never contented with the unthinking adoption of the methods and instruments of investigation which he found in use, but was always designing new ones, with a view to increasing the accuracy of observation, and, above all, to obtaining rapidity without sacrificing accuracy. In the latter particular he was indeed a master. He possessed a genius for organization which would undoubtedly have brought him both wealth and fame in the world of business: but he preferred to devote these talents to the service of science, and, because of them, enjoyed work of a sort which most other men would have regarded as drudgery. He once said to the writer, "I *like* to undertake large pieces of routine work." In the great masses of such work done under his direction, the principles of "scientific management" were fully applied. All that could be done by assistants of moderate capacity was left to them, and the whole working time of the experienced specialists was devoted to such parts of the work as they alone could do. To extend the study to the stars of the southern hemisphere, a station was established at Arequipa, Peru, in 1890, and has been actively maintained ever since, and another has more recently been set up in the island of Jamaica.

The results of these carefully reasoned plans have been so extensive that only the principal features can be mentioned here, leaving a host of minor but highly interesting investigations undescribed.

In *visual photometry,* Pickering started almost *de novo,* devising new measuring instruments, with which observations of all the accuracy necessary for his purpose could be made with great rapidity—notably the meridian photometers, with which the brightness of stars is measured, as they cross the meridian, by comparison with some circumpolar star which is always available as a standard. With these instruments more than 45,000 stars have been observed at Cambridge and Arequipa, and the resulting system of visual stellar magni-

tudes has been generally adopted as an international standard. When to these observations, most of which were made by Professor Pickering himself, are added his numerous measures upon variable stars, satellites and other objects, the whole number of photometric settings which he personally made rises to the amazing total of more than a million and a half.

He was also a pioneer in *stellar photography*, and especially in the use of the doublet lenses which combine great light grasp with a wide angle of field, and can with an exposure of an hour or two, record on a single plate the positions and magnitudes of a number of stars which may run into the hundreds of thousands. The Harvard equipment includes instruments of this type ranging from the 24-inch Bruce telescope at Arequipa and the 16-inch Metcalf instrument at Cambridge to the little lenses of one inch aperture which are used to photograph as large a portion of the visible heavens as possible on every clear night. The plates are developed, indexed, and filed in the great "Harvard Photographic Library," which its creator described as "a library of 250,000 volumes, every one unique, and with but a handful of readers to work in it." The very magnitude of the mass of information stored in this vast collection makes it impossible to extract it all; but whenever an object of unusual interest is discovered, it is only necessary to refer to the Harvard plates to find out just where and how bright it was on some three or four hundred dates during the last thirty years. Among the most notable examples of this may be mentioned the recognition of images of the asteroid Eros upon plates taken two and four years before its discovery, and the recent tracing of the history of the brilliant new star in Aquila through an interval of thirty years, up to the very day before the great outburst.

The third principal field of work is in *stellar spectroscopy*. Pickering led again in the photography of stellar spectra with the objective prism, and in the more precise classification of stellar spectra which this made possible. Assisted financially by the liberal aid of the Henry Draper Memorial, he and his very distinguished assistants, Mrs. Fleming and Miss Cannon, studied these spectra, devised the empirical classification of the original Draper Catalogue, and improved upon this by omitting some of the original classes and rearranging others, until the resulting classification proved so convenient, and so remarkably representative of the actual facts, that it was adopted without a dissenting voice by the International Union for Solar Research as a universal standard. The fact, which was first brought out by this investigation, and served as the basis of the final classification, that the spectra of almost all the stars fall into a single sequence, along which each type grades almost imperceptibly into the next, is now recognized as the very foundation of modern astrophysics, and the progress of discovery serves steadily to emphasize the importance of classification according to spectral type in the most diverse problems of sidereal astronomy. In this field, too, the Harvard work is of imposing extent, culminating in the "New Draper Catalogue" containing the spectra of about 215,000 stars, classified by Miss Cannon. Professor Pickering took the liveliest interest in this monumental work, and in the admirably arranged plans for its production; and it is cause for gratification that the first volume saw the light while he was alive to enjoy it.

One other series of investigations that should not be passed over deals with *photographic photometry*. This was one of the chief interests of his later years, and an increasing part of the work of the observa-

tory was devoted to it. The establishment of a standard system of photographic magnitudes proved a difficult and intricate problem, but again the results are of primary importance, for the color of a star, which is best measured by the difference between its visual and photographic magnitudes, proves to be almost as important as its spectral type, to which it is very intimately related. Here again the principal work of observation was done by others—Miss Leavitt, Professor Bailey and Professor King—but the unifying guidance was Pickering's. Closely related to this is the discovery of variable stars, which, previously largely a matter of chance, was reduced to a system, whether by the comparison of plates of the same field taken at different times, or by means of certain spectral peculiarities. The new methods were so successful that the number of variable stars discovered at Harvard within a few years was three times as great as that of all those detected by all the astronomers of the world during the previous history of the science.

Finally, and by no means least, should be recorded his deep interest in, and support of, cooperation between the whole fraternity of astronomers, whether in this country or abroad. There was hardly an organization for the furtherance of any specific astronomical aim, such as the Committee on the "Carte du Ciel" or the Solar Union, in which he did not take an active part, and his counsel and advice were always of weight. But equally influential, though less conspicuous, was his ever generous aid to individual investigators, to whom he was continually transmitting invaluable material from the treasures under his charge, sometimes observations already made, but unpublished, and again data concerning stars which had been put upon his observing lists for that especial purpose. His abiding willingness to use his powerful influence to aid other astronomers in obtaining instruments for the expansion of their researches, or funds to provide assistance in the reduction and publication of their observations, is known to all.

It may be pardonable to speak of one or two instances. In conversation, referring to the Metcalf Telescope, for which he had found the funds to purchase the glass disks for the lens, and provide the mounting, while the figuring of the lens was done, as a labor of love and in his spare time, by the distinguished amateur whose name it bears, "I felt as if a great artist had said to me 'If you will buy the canvas, and the brushes and paint, I will paint you a picture.' "

If a more personal allusion may be excused, it may be recorded that, shortly after the writer's first interview with Professor Pickering (during which he had described his first serious astronomical work, on stellar parallax) a letter arrived from Harvard, saying in substance "I think that it would be useful to determine the magnitudes and spectra of all your stars. If you will send me a list of them, we will have them observed, and send you the results." This involved the photometric and spectroscopic observation of some three hundred stars (the photometric settings being made by Professor Pickering himself) and was offered as an unsolicited contribution to the work of a young and unknown instructor!

The Harvard Observatory never admitted graduate students of the ordinary sort; and doctoral theses are absent from the long list of its publications. But, under Pickering, it was an educational center of the first rank, and its pupils were not the immature students, but the working astronomers of the country. Who among us has not gone to Harvard, enjoyed the delightful hospitality and finished courtesy of the director, and returned, loaded down with

data for investigations new or old, and inspired by his experience with new enthusiasm alike for the magnificent researches of the great observatory, and for his own humbler work?

Such a career deserved unusual recognition, and received it in a merited degree. Almost all the honors of the scientific world fell to his lot, and the list of these distinctions is too long to detail here. But those who knew him will mourn less the disappearance of the distinguished leader of science than the loss of a warm and loyal friend, one of the kindliest and most generous of men.

HENRY NORRIS RUSSELL

PRINCETON UNIVERSITY OBSERVATORY,
February 6, 1919

SOME RECENT CONTRIBUTIONS TO THE PHYSICS OF THE AIR[1]

THERE has come to us from ancient times the story of a foolish man who sold his birthright for a mess of pottage, and that story to-day is right applicable to us physicists, except in one important particular—we haven't even got the pottage. No department of learning has a richer birthright than has the department of physics in meteorology—the physics of the air. And yet the few institutions that even profess to teach this subject in any form offer it through the department of geology, or, more frequently still, that omnivorous department which, for want of a better name, is called the department of geography. Statistical meteorology, if such expression will be permitted, or climatology, is of course of great interest alike to the geologist and the geographer and this they should teach and in great measure do teach, but climatology is no more meteorology than descriptive geography, for instance, is geology. Its value is great and unquestioned, but its function, like the function of geography, is merely to describe and not to explain.

Meteorology, on the other hand, is concerned with causes, it is the physics of the air, a vast subject of rapidly growing importance upon which peace and war alike are becoming more and more dependent. Only yesterday we

> Heard the heavens fill with shouting, and there rained a ghastly dew
> From the nations' airy navies grappling in the central blue;

and to-day

> Saw the heavens fill with commerce, argosies of magic sails,
> Pilots of the purple twilight, dropping down with costly bales.

It is, therefore, no longer an opportunity, a shamefully neglected opportunity, that invites, but an imperative duty that commands our leading institutions to add to the various subjects taught, studied and investigated in their departments of physics that eminently valuable and fascinatingly difficult branch of geophysics—the physics of the air.

No doubt the great majority of colleges and universities would find it highly impracticable to add a proper course in meteorology to their present long list of electives. Neither is it practicable nor desirable for all of them to teach anthropology, say, despite its fascination, nor even any whatever of the a-to-z kinds of engineering. But it is insisted with all possible emphasis that if taught at all it be taught right—taught as a branch of physics. It is also insisted that there is a growing need, especially in connection with both the science and the art of aviation, for young men who understand the phenomena of the atmosphere. Nor should it be forgotten that when our army called for men trained in meteorological physics it called in vain—they did not exist. Furthermore, it would be a godsend to our national Weather Bureau if in the future it could secure a larger portion of its personnel from among university gradu-

[1] Address of the vice-president and chairman of Section B—Physics, American Association for the Advancement of Science, Baltimore, December, 1918.

ates highly trained in the subjects with which they have to deal. And, finally, it is insisted that the physics of the air offers many opportunities to the creative scholar, and every university must realize that its paramount duty is the fostering of research and the training of investigators, for in no other way can it meet the growing and compelling demands of a progressive civilization.

It must be admitted, however, that it is not now easy to give a connected course on atmospheric physics, for there is no suitable text and the isolated articles upon which such a course must needs be based are scattered through the journals from Dan to Beersheeba and buried under a babel of tongues. But this is only a difficulty, and not, in the face of imperative needs, an excuse. A far greater and very real difficulty has, it is true, confronted most of us, for, until the last decade, or less, several important lectures in such a course would of necessity have been restricted to the same brevity as characterizes Horrebow's famous chapter on snakes in his "Natural History of Iceland"—there aren't any. Some of these lectures are still unwritten—tantalizing challenges to the skill of the experimentalist and acumen of the analyst—while others have been at least partially supplied, a few of which it will be interesting to review in what follows.

TEMPERATURE OF THE FREE AIR

Although efforts to determine the temperature of the free air by means of thermometers carried by kites were made as early as 1749, the experiments being conducted at Glasgow by Alexander Wilson and his pupil Thomas Melville; and although, beginning with Jeffries in his ascent from London in 1784, balloonists have often carried thermometers on their flights, it was only after the development of self-recording instruments and the sounding balloon—both at the very end of the last century—that the vertical distribution of temperature up to even 7 or 8 kilometers became at all accurately known. As is now known, and as shown in Fig. 1, the average temperature decreases slowly with elevation near the surface, then more and more rapidly to a maximum at some such considerable altitude as 7 to 9 kilometers, where it roughly approaches the adiabatic rate for dry air of approximately 1° C. per 103 meters.

These are the observed facts; but here too, as in the investigations of other physical phenomena, a knowledge of what happens is only so much raw material out of which some one happily may fashion the finished product—why it happens. In this case the why is found in the presence of water vapor in the air, its condensation and the latent heat thus rendered sensible. As air is carried to higher levels by vertical convection it progressively expands against the continuously decreasing pressure, and thereby does work at the expense of its own heat. During the dry stage of this convection, that is, until saturation is attained, the cooling is roughly at the rate of 1° C. per 103 meters increase of elevation. Immediately condensation begins, however, latent heat is set free and the rate of cooling with elevation correspondingly decreased. But as the amount of vapor condensed per degree drop in temperature decreases with the temperature, it follows that the latent heat set free and the corresponding check in the rate of cooling with elevation also decreases. Hence the continuous temperature-elevation coordinates of a rising mass of saturated air form a curved line. Furthermore, the curve thus formed approximately coincides with the average temperature-altitude curve of the free air throughout all cloud levels, or from 0.5 kilometer, say, to 9 kilometers, or thereabouts, above sea level. This agreement necessarily occurs more or less closely during every rain and in all deep clouds and, therefore, very frequently. Nor can there often be much departure from it between such occasions for during these intervals the whole of this portion of the atmosphere is, as a rule, simultaneously warmed or cooled, and thus the curve in question usually shifted essentially parallel to itself.

It appears, then, that the average tempera-

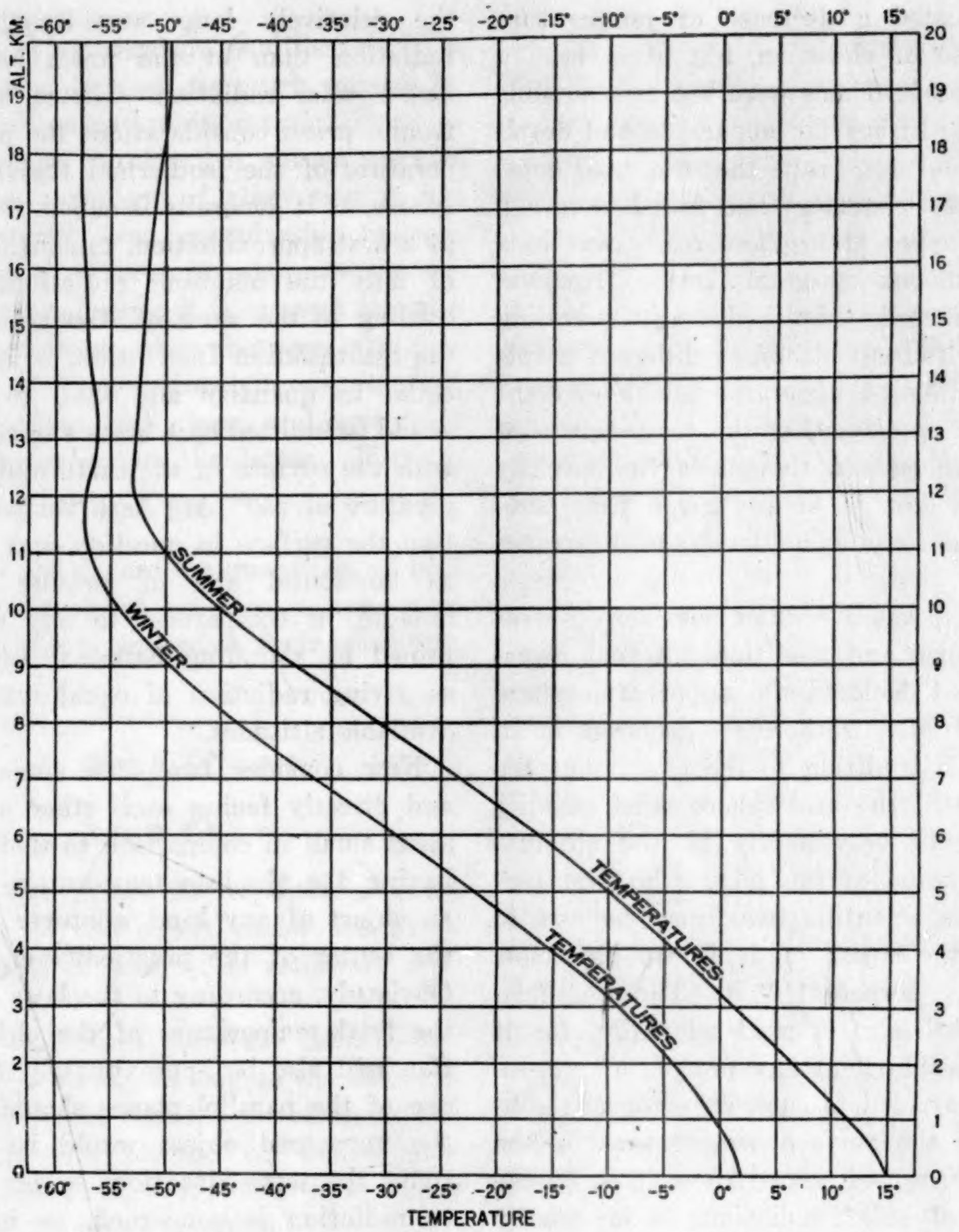

FIG. 1. Temperatures of the air at different elevations.

ture gradient (rate of decrease of temperature with elevation) of the free air is approximately that of a rising mass of saturated air; and for the reasons (*a*) that frequently the air is rising and saturated, and (*b*) that departures from the thus established saturation curve develop but slowly, as explained, and are soon eliminated by its reestablishment.

THE ISOTHERMAL STATE OF THE UPPER AIR

In April, 1898, Teisserenc de Bort began at Trappes, near Paris, a long series of frequent atmospheric soundings with small balloons carrying automatic registering apparatus. Among other things, he soon obtained temperature records that indicated the existence either of surprising errors in his apparatus, or of wholly unsuspected conditions in the upper atmosprere. The records generally were tolerably satisfactory up to some 10 to 12 kilometers—satisfactory, because through at least the upper half of this region they showed the temperature to decrease with elevation at, very roughly, the adiabatic rate for dry air. But somewhere in the neighborhood of 11 kilometers elevation everything seemed to go wrong, for from here on the records no

longer indicated a decrease of temperature with increase of elevation, but often even a slight increase! There were but two possible conclusions. Either the apparatus had developed, in actual use, faults that the cross questioning of the laboratory had failed to reveal, or else the upper atmosphere really was in a most unorthodox thermal state. However, numerous records obtained with sounding balloons at different places, by different people and with different apparatus all showed the same thing, namely, that the temperature of the upper atmosphere, though varying slightly from day to day, is, at any given time, substantially the same at all levels, as illustrated by Fig. 1.

Here, then, was a conflict between observational evidence and tradition. Actual measurements had declared the upper atmosphere to be essentially isothermal—declared it in the face of a tradition to the effect that the temperature of the atmosphere must steadily decrease to, or very nearly to, the absolute zero. The name of the joker who first perpetrated this scientific hoax may be lost to fame, but the worst of it is we physicists thoughtlessly perpetuated it. The qualification, thoughtlessly, is used advisedly, for it seems impossible than any process of reasoning could have led to such an erroneous conclusion. If the surface temperature of the earth is maintained, as we know it is, by the absorption of solar radiation, it is equally certain that in turn the temperatures of objects in the full flood of the necessarily equivalent terrestrial radiation can not drop to zero; nor, therefore, can the air, generally, cool by convection to a lower temperature than that which this radiation can maintain. These ideas, so simple that they seem hardly worth expressing, embody the fundamental explanation of why the upper atmosphere is essentially isothermal.

In addition to being exposed all the time to earth radiation the upper air is also exposed much of the time to solar radiation, but there is abundant evidence that the atmosphere at all levels is far more absorptive of the relatively long wave-length terrestrial radiation than of the much shorter wave-length solar radiation. Hence in computing from *á priori* considerations the probable temperature of the isothermal region, or stratosphere, as it generally is called, it is sufficient, as a first approximation, to consider the effect of only the outgoing radiation, which, according to the work of Abbot and Fowle, of the Smithsonian Institution, is approximately equal in quantity and kind to that which would be emitted by a black surface coincident with the surface of the earth and at the temperature of 259° A. As a further simplification the surface in question may be regarded as horizontal and of infinite length and breadth in comparison to any elevation attained by sounding balloons, and, therefore, as giving radiation of equal intensity at all available altitudes.

Now consider two such surfaces, parallel and directly facing each other at a distance apart small in comparison to their width, and having the absolute temperature T_2, and let an object of any kind whatever be placed at the center of the practically enclosed space. Obviously, according to the laws of radiation, the final temperature of the object in question will also be approximately T_2. If, now, one of the parallel planes should be removed the uncovered object would be in substantially the same situation, so far as exposure to radiation is concerned, as is the atmosphere of the isothermal region in its exposure to radiation from the lower atmosphere. Of course each particle of the upper air receives some radiation from the adjacent atmosphere, but this is small in comparison to that from lower levels and may, therefore, provisionally be neglected. Hence the problem, as an approximation, is to find the temperature to which an object, assumed infinitesimally small, to fit the case of a gas, will come when exposed to the radiation of a single black plane at a given temperature, and of infinite extent.

But whether an object lies between two planes of equal temperature, as above assumed, or, like the upper air, faces but one,

it clearly is in temperature equilibrium when and only when it loses as much energy by radiation as it gains by absorption. Furthermore, so long as its chemical nature remains the same its coefficient of absorption is but little affected by even considerable changes of temperature. Therefore, whatever the nature of the object, since it is exposed to twice as much radiation when between the two planes as it is when facing but one, it must, in the former case, both absorb and emit twice as much energy as in the latter. That is,

$$E_2 = 2E_1$$

in which E_2 and E_1 are the quantities of heat radiated by the object per second, say, when between two planes and when facing but one, respectively.

Again,

$$E_2 = K_2 T_2^{n_2}$$

and

$$E_1 = K_1 T_1^{n_1}$$

in which T_2 and T_1 are the respective absolute temperatures of the object under the given conditions, and K and n its radiation constants.

For every substance there are definite values of K and n which, so long as the chemical nature of the object remains the same, do not rapidly vary with change of temperature. Hence, assuming $K_2 = K_1$ and $n_2 = n_1$, it follows, from the above equation

$$E_2 = 2E_1,$$

that

$$T_2 = T_1 \sqrt[n]{2}.$$

From this it appears that there must be some temperature T_1 below which the radiation of the earth and lower atmosphere will not permit the upper atmosphere to cool, though what it is for a given value of T_2 depends upon the value of n.

But as already explained the value of T_2 is roughly 259° A., and if $n = 4$, the value for a full radiator, it follows that

$$T_1 = 218° \text{ A.},$$

substantially the value found by observation.

STORM EFFECTS ON TEMPERATURE GRADIENTS

Another surprising and, for a time, disconcerting contribution of the sounding balloon to our knowledge of the air relates to the relation of the temperature of the atmosphere to storm conditions. It has long been known that, in general, areas of low pressure—cyclonic areas—are accompanied by inwardly spiralling winds and precipitation; and, conversely, that areas of high pressure—anticyclonic areas—are characterized by outwardly spiralling winds and clear skies. Certainly, then, the inwardly flowing winds of the cyclone must ascend, and the outwardly flowing winds of the anticyclone must be sustained by descending currents. And the next inference, namely, that the air of the cyclone is relatively warm and the air of the anticyclone comparatively cold, seemed equally certain; for, indeed, what else could cause ascent in the one case and descent in the other? But again the facts are not in accord with the simplest and most obvious inference, but just the reverse, through all convective levels, that is, up to the base of the stratosphere, as shown by Figs. 2 and 3, except, in general, near the surface, during the winter. In short. quite contrary to familiar ideas about convection, the ascending air in this case is relatively cold and the descending air comparatively warm. And the stratosphere, as these figures also show, but further confounds this confusion, for here the temperature relations are again reversed, the warmer air being now over cyclones and the colder, above anticyclones.

The facts just stated were, indeed, for a time somewhat disconcerting, but they have helped to the realization that with reference to temperature there are two classes of extratropical cyclones, cold (migratory) and warm (stationary); and also two classes of anticyclones, warm (migratory) and cold (stationary).

That the atmosphere of a stationary anticyclone should average relatively cold, and that of the cyclone comparatively warm, is obvious from the fact that the former occurs only

over cold areas, such as Greenland, Antarctica, etc., and the latter over regions that are warm in comparison with neighboring areas, such as the water southeast of Greenland, the Gulf of Alaska (in the winter), etc. All such cases are readily explained on the principle of thermal convection, and therefore offer nothing new.

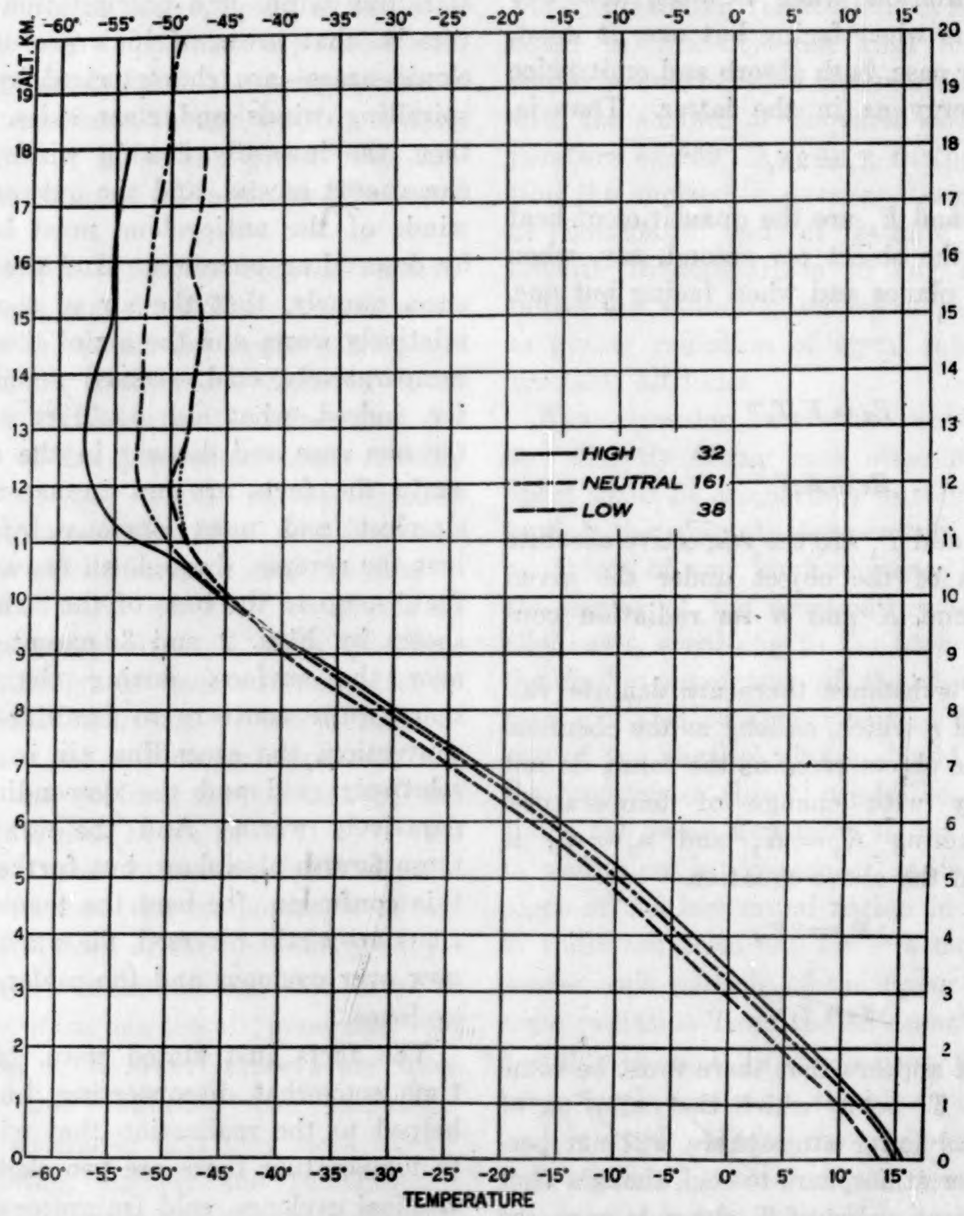

Fig. 2. Relation of summer temperatures to barometric pressure.

The migratory storms, however, at least those of middle latitudes, are quite different. The relation of their temperatures to each other, level for level up to the stratosphere, is just the reverse of that which it would have to be if their circulations were of immediate thermal origin. Presumably, therefore, their circulations are largely driven and their temperatures in part mechanically determined.

As every one knows, the temperature contrast between the regions of low and high latitudes, respectively, leads to an interzonal circulation of the atmosphere. And because of the rotation of the earth this circulation becomes, through a portion of its course, the prevailing winds from the west, that up to near the base of the stratosphere average stronger, and are more nearly constant in direction, with increase of altitude. Now, whatever the origin of the migratory anticy-

clone, a subject that still requires further investigation, one of its chief features is deep winds from higher latitudes in its eastern portions. These winds, because of the rotation of the earth, necessarily lose more or less of such west-to-east velocity as they previously surface up to near the base of the stratosphere. This increase of pressure in turn forces the loaded air to descend, warming on the way according to the adiabatic gradient of 1° C. per 103 meters (if free from clouds) and thereby raising the temperature at all levels

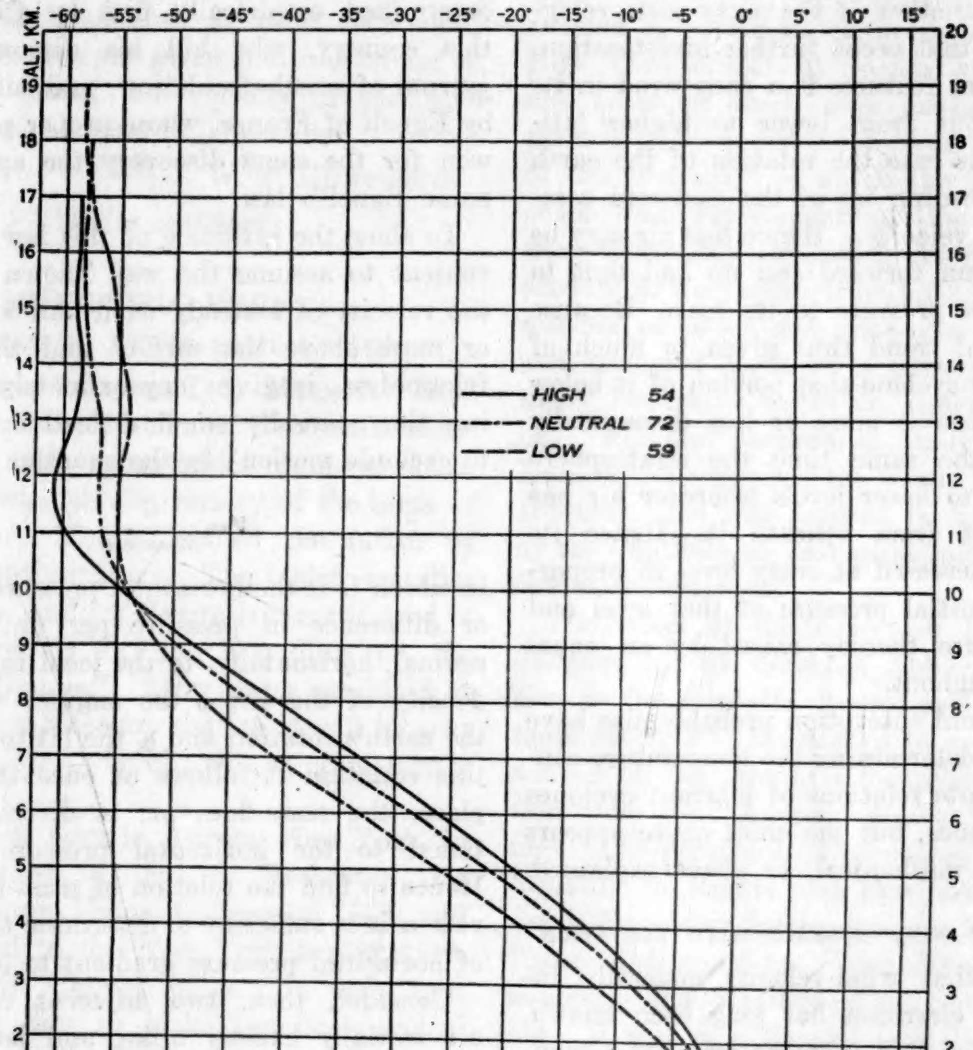

FIG. 3. Relation of winter temperatures to barometric pressure.

may have had. They lag in the midst of the general circulation. Hence the prevailing westerlies flow over them as over a mountain barrier. But by this overflow the westerlies produce at least three different effects: (*a*) They load the atmosphere over which they pass, and thus increase the pressure from the through which it passes. (*b*) They bodily lift the stratosphere whose pressure thereupon tends to decrease at every level in proportion to the initial pressure at that level—a result that would produce dynamically an equal drop in temperature throughout the stratosphere. (*c*) By their own dynamical cooling, and at

least until the pressure of the upper atmosphere has become readjusted, they establish at the base of the stratosphere a layer of minimum temperature.

These conclusions are in full accord with Figs. 2 and 3.

Similarly, whatever the origin of the migratory cyclone, another of the many meteorological problems that needs further investigation, one of its chief features is a deep wind in its eastern portions from lower to higher latitudes. In this case the rotation of the earth leads to a speeding up of the eastward component of the velocity. Hence this air may be expected to run forward and up and thus to produce a low pressure to its rear. Because of the upward trend thus given to much of the air in the cyclone that portion of it below the stratosphere is more or less dynamically cooled. At the same time the stratosphere bodily drops to lower levels wherever air has been removed from beneath it. Hence its pressure is increased at every level in proportion to the initial pressure at that level and its temperature thereby raised by an equal amount throughout.

Radiation and absorption probably also have some part in determining the temperature conditions and interrelations of migrant cyclones and anticyclones, but the chief cause appears to be purely mechanical, as above explained.

THE LAW OF WIND-INCREASE WITH ELEVATION

The fact that wind-velocity generally increases with elevation has long been known, but the law of this increase was not formulated for any levels until only a few years ago, nor the cause back of this law revealed until still more recently. The law in question applies only to that portion of the atmosphere that lies between the elevations of 3 to 4 and 8 to 9 kilometers. Nor could it in any modified form be satisfactorily extended to other levels—not much below 3 kilometers, because of the irregular disturbances due to surface friction, innumerable barriers, and convectional turbulence; nor much beyond 9 kilometers, because not far from this level the vertical temperature gradient, upon which the winds largely depend, rather abruptly and greatly changes. The form of this law, that applies as a first approximation to so much of the atmosphere, is very simple. It says merely that the velocity of the wind varies inversely with its density, or, in other words, that the mass-flow is a constant. This was determined empirically first by Clayton, of this country, who hid his discovery in a journal of small circulation; and subsequently by Egnell of France, whose proper publication won for the same discovery the appreciative name Egnell's law.

To show the rationale of this law it is convenient to assume the well known fact that the velocity of a steady wind half a kilometer or more above the surface and thus nearly frictionless, is given approximately (neglecting the generally small deflective force due to cyclonic motion) by the equation

$$V = \frac{G}{\rho 2\omega \sin\phi}$$

in which G is the horizontal pressure gradient, or difference in pressure per unit distance normal, horizontally, to the local isobar, ρ the density of the air, ω the angular velocity of the earth's rotation and ϕ the latitude. From this equation it follows at once that at any place, the mass-flow, ρv, is directly proportional to the horizontal pressure gradient. Hence to find the relation of mass-flow to elevation it is sufficient to determine the relation of horizontal pressure gradient to elevation.

Consider, then, two adjacent columns of air initially exactly alike, and let the temperature of one be increased over that of the other by the same amount throughout. Each isobaric level in the warmed column will thereby be raised in direct proportion to its original height, and the horizontal pressure thus established at each height h will be proportional to the product of this lift by the local density. That is

$$\frac{G}{G'} = \frac{h\rho}{h'\rho'}.$$

But from the height of 3 or 4 kilometers above sea level up to that of 8 or 9, the density of the atmosphere is roughly inversely propor-

tional to the altitude. Hence, to this same crude approximation, G is also constant through the given range of levels.

Now the actual temperature distributions in the atmosphere at different latitudes are essentially as assumed in the two adjacent columns. Hence the horizontal gradient and therefore the mass-flow, ρv, must be roughly constant between the given limiting levels; or, as usually stated, the velocity of the wind inversely proportional to its density.

W. T. HUMPHREYS

(*To be continued*)

SCIENTIFIC EVENTS

MEMORIAL TO LEWIS HENRY MORGAN

TEMPORARILY displayed in Memorial Hall, at the American Museum of Natural History, New York, is a bronze tablet commemorating the one hundredth anniversary of the birth of Lewis Henry Morgan, called the father of American anthropology. The tablet embodies an Iroquois Indian decorative motif and a wampum record of the founding of the "Iroquois League." After being exhibited at the American Museum, the tablet will be sent to Wells College, where it will be permanently installed.

Morgan was born in Aurora, New York, in 1818, and died in 1881 at Rochester. He graduated from Union College in 1840, and was admitted to the New York bar in 1842. In 1855, his interest in certain rich iron deposits led him to make practical explorations into northern Michigan, at that time a wilderness. Here he became interested in the habits and labors of the beaver, and after several years of observation and study wrote his "American Beaver and His Works," which is still considered the most authentic book of its kind.

Early in his life, Mr. Morgan had become a member of a secret society known as the Gordian Knot. This society was accustomed to meet on the ground of the ancient confederacy of the "five nations," holding its council fires at night on the former lands of the Mohawks, Oneidas, Onondages, Cayugas and Senecas. Gradually its members developed a curiosity about the history, institutions and government of the Indians, and began to gather together odd scraps of information about them. Mr. Morgan's interest became so strong that he devoted himself to serious study of the subject. He wrote a number of papers which were read before the New York Historical Society and elsewhere, and some of which were published in book form in 1851 under the title of "The League of the Iroquois," in which the social organiation and government of the confederacy were thoroughly explained, the first scientific account of an Indian tribe. He later wrote a number of books and papers on Indian life, and gathered together a library containing many important works on American ethnology. For the purpose of studying the Six Nations, he organized the Grand Order of the Iroquois. He was assisted in his researches by the Smithsonian Institution and the United States Government.

The tablet at the American Museum was designed by Mr. Gohl, of Auburn. In addition to the symbolic decorations and various facts about Mr. Morgan's life and works inscribed on the tablet, is the following quotation from his "Ancient Society": "Democracy in Government, Brotherhood in Society, Equality in Rights and Privileges and Universal Education foreshadow the Next Higher Plane of Society to Which Experience, Intelligence and Knowledge are Steadily Tending. It will be a Revival in a Higher Form of the Liberty, Equality and Fraternity of the Ancient Gentes."

THE BRITISH DYE INDUSTRY[1]

THE works and appliances of the German firms remain substantially undiminished in extent and unimpaired as to organization, while they still possess a large body of expert chemists and engineers fully acquainted with the details of the business, though doubtless there have been serious losses in the course of the war. It is, however, satisfactory to learn from the address of Lord Armaghdale,

[1] From *Nature*.

the chairman of Levinstein's, that, in his opinion, provided sufficient financial support is forthcoming, this country may be rendered independent of German dyestuffs. On the scientific side, he added, success is certain. There is in this country a larger amount of chemical talent than has hitherto been recognized, and during the war many university professors and others occupied with purely scientific research have given valuable assistance to the color industry, as well as in other departments of manufacture.

Considering the difficulties to be overcome in the revival of chemical industries in this country at the beginning of the war, and, as compared with Germany, the serious lack of organization and of scientifically trained assistance, the success so far achieved is encouraging in the highest degree. There is no justification for the gloomy view of the situation sometimes taken, and if the scheme now working under the Board of Trade is not perfect, it is, at any rate, a step in the right direction, and has been accepted by the dye-makers and the dye-users.

The trade and licensing committee referred to in the scheme has now been constituted under Lord Colwyn as chairman. The following are the other members: Mr. Henry Allen, Mr. Milton Sharp and Mr. Lennox B. Lee, nominated by the Color Users' Committee; Mr. T. Taylor, representing the paint and varnish manufacturers; Dr. Herbert Levinstein and Mr. J. Turner, nominated jointly by British Dyes, Ltd., and Levinstein's, Ltd.; Mr. W. J. Uglow Woolcock, M. P., nominated by the Association of British Chemical Manufacturers; and Mr. W. H. Dawson, nominated by the president of the Board of Trade. The commissioner for dyes, Sir Evan Jones, M.P., will be an *ex officio* member without a vote. Dr. H. Levinstein is the well-known managing director of Levinstein's, Ltd., and he will control the scientific and manufacturing operations of the new corporation resulting from the fusion of British Dyes and Levinstein's. Mr. J. Turner has been a director of British Dyes, Ltd., for several years, and he will be largely influential in the business arrangements of the conjoint firms.

The functions of the committee now constituted will be to determine the colors and intermediates which shall be licensed for import into the United Kingdom after the conclusion of peace, and to advise the Commissioner for Dyes as to the colors and intermediates the manufacture of which in this country should be specially encouraged.

It is satisfactory to find that the Port Ellesmere indigo factory has been in full work for some time, and that land has been secured for considerable extensions of the works in the near future.

DISTRIBUTION OF THE MEMBERSHIP OF THE AMERICAN CHEMICAL SOCIETY

THE membership of the American Chemical Society was 12,203 at the end of the year 1918, having increased 1,600 during the year. The sections of the society and the number of members not in arrears on November 30, 1917 and 1918 were as follows:

Local Section	1917	1918
Alabama	52	111
Ames	34	19
California	292	294
Central Texas	59	42
Chicago	649	627
Cincinnati	165	180
Cleveland	278	319
Columbus	97	101
Connecticut Valley	109	98
Cornell	39	35
Delaware	...	268
Detroit	102	105
Eastern New York	72	85
Georgia	76	73
Indiana	157	157
Iowa	62	75
Kansas City	155	141
Lehigh Valley	94	98
Lexington	22	23
Louisiana	59	64
Louisville	19	20
Maine	53	55
Maryland	142	211
Michigan Agricultural College	31	24
Milwaukee	95	97
Minnesota	121	121
Nashville	26	26

Nebraska	48	52
New Haven	70	82
New York	1,594	1,799
North Carolina	40	43
Northeastern	633	664
Northern-Intermountain	17	23
Oregon	35	33
Philadelphia	737	716
Pittsburgh	401	441
Puget Sound	76	91
Rhode Island	85	92
Rochester	56	52
St. Louis	149	160
Southeast Texas	43	38
Southern California	157	183
South Carolina	24	26
South Dakota	29	21
Syracuse	149	127
Toledo	43	46
University of Illinois	115	106
University of Michigan	47	34
University of Missouri	14	12
Vermont	28	18
Virginia	97	111
Washington, D. C.	402	578
Western New York	181	202
Wisconsin	93	95
	8,423	9,166

SCIENTIFIC NOTES AND NEWS

THE gold medal of the National Institute of Social Sciences has been awarded to Dr. Wm. H. Welch, of the Johns Hopkins Medical School.

DR. HENRY A. BUMSTEAD, professor of physics at Yale University, has returned from France, having been engaged in war work abroad since 1917.

DR. LAFAYETTE B. MENDEL, professor of physiological chemistry in Yale University, who has been overseas as a representative of the U. S. Food Administration on the Inter-Allied Scientific Food Commission, has returned to the United States.

MAJOR GENERAL WILLIAM C. GORGAS, U. S. Army, retired, will return from Guatemala to Washington, D. C., in February, and on his return to South America in the spring will be accompanied by Mrs. Gorgas.

COLONEL G. A. BURRELL, of the Chemical Warfare Service, returned to private chemical engineering work at Pittsburgh in January. He was called to Washington by the Bureau of Mines early in the war, to take charge of the research organization that later became the American University Experiment Station of the Chemical Warfare Service.

AT the recent meeting of the Mathematical Association of America Professor Herbert Ellsworth Slaught, of the University of Chicago, was elected president.

FRED RASMUSSEN, professor of dairy husbandry, The Pennsylvania State College, State College, Pa., was, on January 21, 1919, appointed secretary of agriculture for the state of Pennsylvania and left immediately to take up his new duties at Harrisburg.

CARL N. AUSTIN, who went from the Sears-Roebuck laboratories with a commission as first lieutenant in Gas Defense, has recently been appointed director of the First Corps Gas School located at Gondrecourt, Meuse, France.

LIEUTENANT JOHN P. TRICKEY, a member of the Chicago Section of the American Chemical Society, has been promoted to a captaincy in the Chemical Warfare Service, and is on duty in France.

DR. KEIVIN BURNS, of the division of optics, Bureau of Standards, is absent on an extended trip abroad in connection with his scientific work.

THE Geological Society, London, has made its awards as follows: Wollaston medal, Sir Aubrey Strahan, director of the British Geological Survey; Murchison medal, Miss Gertrude L. Elles, Newnham College, Cambridge; Lyell medal, Dr. W. F. Hume, director of the Geological Survey of Egypt; Bigsby medal, Sir Douglas Mawson; Wollaston fund, Dr. Alexander Logie Du Toit, Geological Survey of South Africa; Murchison fund, Mrs. Eleanor M. Reid; Lyell fund, Mr. John Pringle, Geological Survey of England and Wales, and Dr. Stanley Smith, University College, Aberystwyth.

The following committees have been named by the president of the American Chemical Society:

1. Committee to Cooperate with the Society for the Promotion of Engineering Education on Educational Problems: H. P. Talbot, R. H. McKee, S. W. Parr.

2. Committee on Publication of Compendia of Chemical Literature: Julius Stieglitz, John Johnston, E. C. Franklin, J. C. Olsen, James Kendall.

3. Committee to Consider Allocation of Federal Grants for Scientific and Industrial Research: W. R. Whitney, C. L. Alsberg, John Johnston, W. D. Bigelow, Wm. McPherson.

4. Committee to Formulate a Method of Cooperation with the National Research Council: W. D. Bancroft, Atherton Seidell, W. F. Hillebrand, F. G. Cottrell, C. L. Parsons.

5. Committee on Coordination of Chemical Work within the War Department: C. H. Herty, E. P. Kohler, H. P. Talbot, John Johnston.

6. Omnibus Committee for Spring Meeting: A. D. Little, B. C. Hesse, F. M. Dorsey, T. B. Wagner, R. F. Bacon, C. G. Derick, L. C. Drefahl.

We learn from the *Journal* of the American Medical Association that a health commission of the Allies has been formed containing representatives of most of the large nations allied against Germany. A subcommission was recently appointed by Professor Santoliquido, delegate from Italy, and president of the commission. The subcommission will meet in Paris on the first or fifteenth of each month to consider the most important sanitary problems regarding demobilization, the occupation of territory formerly invaded, the military occupation of enemy territory as related not only to the health of the troops, but also to the civilians concerned. The personnel of the subcommission is: president M. le Professeur Santoliquido, Conseiller d'Etat Délégué de l'Italie dans le Comité de l'Office International d'Hygiène publique; M. le Médecin Principal de premiere Class Maistriau, Commandant du Groupement Régional du Service de Santé à Rouen; M. le Médecin Général Jan; M. le Col. Richard P. Strong, Director Department of Medical Research and Intelligence, A. R. C., M. le Col. W. W. O. Beveridge, C.B., D.S.O., Assistant Director of Medical Services for Sanitation, Professor of Hygiene Royal Army Medical College; M. le Médecin Major Levi; M. Coussol; M. de Lieutenant Colonel Médecin Professeur A. Castellani; M. de Cazotte, Ministre Plénipotentaire, Director de l'Office International d'Hygiéne publique; M. le Docteur Pottevin, Directeur Adjoint.

Promotions in, and appointments to, the Civil Division of the Order of the British Empire for services in connection with the war were published on January 9. The list includes five Knights Grand Cross of the Order (G.B.E.), six Dames Grand Cross (G.B.E.), forty-nine Knights Commanders (K.B.E.), one hundred and seventy-eight Commanders (C.B.E.), and five hundred and thirty Officers (O.B.E.). *Nature* selects the following names of men known in scientific circles: *K.B.E.:* W. J. Pope, FR.S., professor of chemistry, University of Cambridge; Aubrey Strahan, F.R.S., director of the Geological Survey of Great Britain; Cecil L. Budd, Non-ferrous Metals Department, Ministry of Munitions; and W. J. Jones, Iron and Steel Production Department, Ministry of Munitions. *C.B.E.:* J. W. Cobb, Livesey professor of coal, gas and fuel industries, University of Leeds; H. H. Dale, F.R.S., director of pharmacology and chemotherapy under the Medical Research Committee; A. Eichholz, senior assistant medical officer, Board of Education; J. C. M. Garnett, principal, Municipal College of Technology, Manchester; Lieutenant Colonel R. J. Harvey-Gibson, professor of botany, University of Liverpool; and P. Chalmers Mitchell, F.R.S., secretary of the Zoological Society of London. *O.B.E.:* J. B. Bailie, professor of philosophy, University of Aberdeen; W. Foord-Kelcey, professor of mathematics and mechanics, Royal Military Academy; and W. E. S. Turner, head of the department of glass technology, University of Sheffield.

In the course of lectures of the Chicago Academy of Sciences dealing with problems of reconstruction, one on "Scientific Leadership of the World" was given by Professor

Henry Crew, Northwestern University, on February 14. On March 21 in the series of lectures on Swedish Contributions to Science which are to be given under the auspices of the Swedish Study League in cooperation with the Chicago Academy of Sciences, Professor Crew will speak on "Swedish Contributions to the Science of Physics."

A COURSE of nine lectures on dynamical meteorology is being given at the Meteorological Office, London, by Sir Napier Shaw, reader in meteorology in the University of London. Each lecture is followed by a conversational class. The informal meetings at the Meteorological Office for the discussion of important current contributions to meteorology, chiefly in colonial or foreign journals, will be resumed on April 28.

ON January 15, Dr. George T. Moore, director of the Missouri Botanical Garden, spoke before the St. Louis Natural History Museum Association at the Public Library, on "The Educational Value of the Missouri Botanical Garden."

EFFORTS are being made to establish a chair of mathematical physics at the University of Edinburgh in memory of the late Professor Tait.

DR. CLARENCE JOHN BLAKE, Walter Augustus Lecompte professor of otology, emeritus, in the Harvard Medical School, died at his home in Boston on January 29, in the seventy-sixth year of his age.

WE learn from the *Journal* of the Washington Academy of Sciences of the death of Captain Howard E. Ames, medical director, U. S. N., retired, who died on December 27, 1918. Dr. Ames had been an officer in the Navy since 1875, and had been on the retired list since 1912. He served as medical officer on board the *Bear,* which rescued General Greely and his party in the Arctic regions. He was a member of the Biological Society.

WE learn from *Nature* that Casimir De Candolle, died on October 3, 1918, at Geneva, where he was born in 1836, and where the greater part of his life had been spent. Casimir De Candolle made valuable additions to the sum of botanical knowledge, though his work was not of such fundamental importance as that of his father, Alphonse, and grandfather, Augustin.

MR. ANDREW BRAID, hydrographic and geodetic engineer of the U. S. Coast and Geodetic Survey, and chairman of the U. S. Geographic Board, has died in his seventy-third year.

DR. GABRIEL MARCUS GREEN, instructor in mathematics in Harvard University, died in Cambridge on January 24, in the twenty-eighth year of his age.

DR. W. MARSHALL WATTS, who while engaged as a science teacher in an English school carried on valuable work on spectroscopy, died on January 13, at the age of seventy-four years.

THE *Journal* of the American Medical Association reports the following deaths from influenza in Brazil: Dr. T. Bayma, the distinguished physician and bacteriologist of S. Paulo, director of the bacteriologic and the vaccine institutes there, aged fifty-five; Dr. Santos Moreira, a leading pediatrist of Rio de Janeiro, director of the *Medicina Clinica,* and Dr. Paulo Silva Araujo, a leading microbiologist, who published in 1915 his "Vaccine Therapy of Bronchial Asthma."

THE American Chemical Society will hold its spring meeting at Buffalo beginning on the morning of April 8.

IT is announced that Genera Insectorum, the great work describing all the genera of insects, published at Brussels, is to be continued. When the country was invaded in 1914, several parts were about to be published; these are to appear in 1919. The stock of the previously published parts was saved, and is now available.

THE laboratory of forest pathology of the Bureau of Plant Industry, U. S. D. A., Dr. James R. Weir in charge, has been removed from Missoula, Montana, to Spokane, Washington, where it will be permanently installed in a fireproof building. The most intensive work of this laboratory is centered in the great white pine forests of Idaho. To promote pathological investigation in this region, a

permanent field station will be established; also a forest pathological museum. All future communications should be addressed to Laboratory of Forest Pathology, Spokane, Washington.

Reasons for continuing the Chemical Warfare Service as a permanent branch of the War Department were presented to the House Committee on Appropriations by General Wm. L. Sibert. In part, he said: "An organization of this kind would have as its biggest element a research branch, the function of which branch would be to keep abreast of the times in all of the chemical appliances or substances necessary or useful in war and, if the use of gas is continued or authorized, the training of troops in the use of gas masks and things of that sort. That would be a part of its functions, but whether gas is used or not there are other chemical substances, such as smokes, that have a tactical use in warfare and the use of which is growing. I refer to the making of screens behind which troops can advance. We would also have a proving ground force in connection with our research force to try out appliances that were developed either in our own laboratories or found abroad."

The American Museum will continue its Second Asiatic Zoological Expedition for another year. The first expedition sailed from the United States in March, 1916, and the second in June, 1918, both under the leadership of Mr. Roy C. Andrews, of the department of mammalogy. So far Mr. Andrews has canvassed especially the Chino-Tibetan border and western tropical China as far as Burma. He is at present in Peking and proposes, as soon as the spring weather arrives, to proceed to Urga in northern Mongolia. This town is situated near the junction of two life zones, the Siberian and the Mongolian and Central Asian. In this region Mr. Andrews expects to take moose, elk, wild boar and other large game. After a four months' stay in northern Mongolia, he hopes to hunt big-horn sheep along the Chino-Mongolian frontier. The species of mountain sheep found here is large, with horns measuring sixty inches. In following out the present program the expedition plans to be back in New York some time in February, 1920.

First Lieutenant Tracy I. Storer, Sanitary Corps, has been discharged from military service and has returned to his former position at the museum of vertebrate zoology at the University of California after an absence of sixteen months.

Mr. H. F. Staley, formerly professor of ceramic engineering at Iowa State College, joined the staff of the Bureau of Standards in December as metallurgical ceramist.

The bureau of economic geology and technology of the University of Texas will cooperate with the United States Geological Survey in making explorations for potash in the western part of the state. Orby C. Wheeler has been engaged to take charge of the work.

Professor Fred W. Ashton has been granted a leave of absence by the University of the Philippines and has taken over new duties as carbonization supervisor with the Chemical Warfare Service at Manila, P. I.

Mr. H. C. Raven, of the Smithsonian Institution, has returned to Washington from the island of Celebes, and has gone to Cornell University to continue his studies. Mr. Raven has collected in the East Indies during the last six years more than four thousand mammals and five thousand birds for the National Museum.

Henry Schmitz, Rufus J. Lackland fellow in the Missouri Botanical Garden, who has been in the Naval Reserves since the beginning of the war, has returned to resume his work at the Garden.

Nature states that Sir Lazarus Fletcher will retire from the directorship of the Natural History Museum, under the age limit, on March 31. The office was made in 1856, under the style of superintendent of the Natural History Departments, so that the trustees of the British Museum might obtain the services of Sir Richard Owen, who supervised the planing of the new mueum at South Kensington, and retired shortly after its com-

pletion in 1884. Under the style of director, Sir William Flower succeeded Sir Richard Owen, and he retired in 1898. For the next decade Sir E. Ray Lankester was director, and he was followed by Sir Lazarus Fletcher early in 1910.

DR. J. D. FALCONER, lecturer in geography in Glasgow University, has been granted further leave of absence in order that he may act at the first director of the Geological Survey of Nigeria.

UNIVERSITY AND EDUCATIONAL NEWS

A GIFT of $50,000 from Lieutenant Howard H. Spaulding, has been made for the physiological laboratory building fund of Yale University. The principle of this fund may be used by the university at any time in its discretion for the construction of a physiological laboratory and meanwhile the income is to be used annually in meeting the expenses of the department of physiology.

MR. GEORGE BONAR, president of the Dundee Chamber of Commerce, has given £25,000 for commercial education in University College, Dundee.

THE Royal Edinburgh Asylum for the Insane has offered an endowment of £10,000 towards a chair of mental diseases in the University of Edinburgh.

PLANS for the introduction of a course on public health and industrial medicine in the college of medicine of the university of Cincinnati are being made by Dean C. R. Holmes. The course has the support of the United States Public Health Service and it is planned to conduct it on the cooperative basis somewhat like that used in the college of engineering.

PROFESSOR HAL W. MOSELEY has been promoted to be associate professor of chemistry in Tulane University, New Orleans, La.

PROFESSOR E. O. HEUSE, formerly instructor in physical chemistry at the University of Illinois, and later professor of chemistry at Monmouth College, Monmouth, Ill., has been appointed professor of chemistry and head of the department at Southern Methodist University, Dallas, Texas.

DISCUSSION AND CORRESPONDENCE

APPLIED PSYCHOLOGY

TO THE EDITOR OF SCIENCE: At the close of his interesting address on "Scientific Personnel Work in the Army," Professor Thorndike remarks: "Making psychology for business or industry or the army is harder than making psychology for other psychologists, and intrinsically requires higher talents." It is well that a man should believe whole-heartedly in his own work and magnify it accordingly. But it is a pity to draw comparisons of this sort.

Reduced to its lowest terms, Professor Thorndike's question is: Which is the harder taskmaster, one's employer or one's conscience? And he decides unequivocally in favor of the employer. I should rather say: It depends! For Professor Thorndike, the employer is a creature of iron, who demands an adequate solution of a given problem by a fixed and early date, and who has no grain of sympathy with unsuccessful work and the unsuccessful worker. It is possible, however, that the employer might extend the date: even if he had not the good will, he might be obliged to. It is possible also that he might sympathize with the unsuccessful work, enter into it, and find in it something worthy of commendation and even of publication. Conscience, on the other hand, is for Professor Thorndike an easy mistress; she allows you yourself to ask the questions for which you proceed to find answers. That sort of conscience seems to me to pertain to the dilettante rather than to the man of science. To the scientific investigator the whole front of his science is one great problem, and he plunges in where the obscurity is thickest. He may hesitate between two or three calls: experimental psychologists have, in recent years, been divided on the question whether the problem of perception or the problem of thought is the more insistent: but Professor Thorn-

dike's notion of "ten thousand" possible directions of activity is pure illusion.

The relations of pure and applied science—not that I like those terms—are extraordinarily complex. No one, so far as I know, has ever worked them out with the fulness the subject deserves. It lies on the surface, however, that applied science furnishes its counterpart with a vast number of appliances and procedures which represent standardizations and short-cuts of method, and that pure science on its side furnishes applied science with ideas. If anyone doubts the latter part of this statement, I refer him to the address by my colleague, Professor Nichols, printed in SCIENCE of January 1, 1909. There are, in point of fact, all manner of mutual dependences and mutual relations, and there is no clean-cut antithesis of conscience and employer.

I believe very strenuously in pure science. But I think I see that there is no end of work to be done on both sides of the line that Professor Thorndike draws. I wish him more power to his elbow; and I wish him graduate students as talented, ingenious, adaptable and persistent as our colleges can provide. Only I think it foolish to tell these students how superior they are to their fellow-students in the other field: because—apart from the question of fact—they will do better work in a spirit of humility. Surely there is enough downright, sweating labor for all of us, and surely it is waste of time to argue about priority of talent.

E. B. TITCHENER

THE PUBLICATION OF ISIS

TO THE EDITOR OF SCIENCE: The publication of *Isis*, an international quarterly devoted to the history and philosophy of science, was brutally interrupted in 1914 by the German invasion of Belgium. As I have no direct way of reaching all those who at that time had subscribed to Volumes II. and III., I would be grateful to you if you would kindly insert this account of the future projects of the journal.

The sixth part of *Isis* was in the press in Brussels when war broke out. It will appear as soon as circumstances permit, but I fear this will not be until next autumn. The publication of Volume III., however, will take place soon after, perhaps in 1919, but at the latest in the early part of 1920. The undertaking in its original form met with encouraging support from many quarters; I may be permitted to mention for example that it is for my work in connection with it that the Prix Binoux was awarded to me by the Académie des Sciences of Paris in December, 1915. Yet after four years of work and thought the weaknesses of *Isis* are very obvious to me and I shall endeavor to correct them. Of course, the latter part of Volume II., as well as Volume III., which had already been prepared for publication in 1914, will not greatly differ from Volume I. But from Volume IV. onward considerable changes will be made. It is my ambition to make *Isis* the main center of information in all matters pertaining to the history and philosophy of science and the international organ of New Humanism.[1]

Some of the features which I propose to introduce are as follows:

Instead of publishing in four languages an effort will be made to use only French and English—chiefly, and perhaps exclusively, the latter. Articles written in other languages will be translated into English. More illustrations will be added and will consist mainly of portraits, facsimiles of manuscripts and of rare books. The bibliographical section will contain a larger number of short critical notes. Moreover, from Volume III. or IV. onward I hope to share the editorial responsibilities with other scientists, chiefly with Dr. Charles Singer, of Exeter College, Oxford, who is known as a historian of medicine and a medieval scholar.

The new *Isis* will only publish shorter articles. The longer and more monographic ones would be included in Singer's *Studies in the*

[1] Those who are not already acquainted with this movement to humanize science and to show its relationship to all other aspects of human life and thought, will find an explanation of it in *Scientia*, Bologna, March, 1918, or in the *Scientific Monthly*, New York, September, 1918.

History and Method of Science. The first volume of this work was issued by the Oxford University Press in 1917. I understand that the second volume is now ready for the press and Dr. Singer tells me that he hopes to share with me the editorial responsibilities of the third and succeeding volumes. Thus, *Isis* and the *Studies* would be supplementary one to the other, and between them would provide suitable outlet for new work on the history and philosophy of science.

GEORGE SARTON

CARNEGIE INSTITUTION OF WASHINGTON

A STEADY CALENDAR

TO THE EDITOR OF SCIENCE: The interruption of our recent scientific meetings by the coming of Sunday in the middle of the (Christmas) week—a reputed impossibility that happens every five or six years—is one of the many inconveniences that we half-consciously endure as the result of inheriting a varying calendar from the unscientific past. If in adopting any one of the many improved calendars that have been proposed, we should annually sacrifice upon the altar of reason a single day in ordinary years and two days in leap years, as extra days without week-day names, then Christmas and New Years would always fall on the same day of the week; and by waiting to begin the sacrifice until those holidays come on a Saturday or a Monday, the scientific meetings of the last five days of the year, which have become so well established among us, would never thereafter be broken in half by an interrupting Sunday. Home celebrations and scientific meetings would both profit by the change. How can we best bring it about?

W. M. DAVIS

CAMBRIDGE, MASS.,
January 4, 1919

SCIENTIFIC BOOKS

Forced Movements, Tropisms and Animal Conduct. By J. LOEB. Philadelphia. 1918. Pp. 209, 42 figs.

The scope and character of this volume are in large part explained by the fact that it is offered as one of a series of monographs in which it is proposed to cover the field of recent developments in biology. The announced titles of the volumes scheduled to follow this first number deal, not so much with rational divisions of the science, as with those particular phases of physiology that have been the subjects of investigation at the hands of the respective writers. This general plan, already justified by its success in the treatment of modern advances in physical and biological chemistry, and in human physiology, necessarily results in a less closely coordinated system of monographs when applied to physiology proper—the latest of the sciences to acquire a realization of the analytical significance of quantitative methods of thought.

The first volume of the proposed series, then, endeavors to present within the space of some 170 pages a concise statement of the theory of tropisms, their origin in forced movements under various forms of activation, and their importance for the analysis of animal conduct, including that of *Homo.* Much of the matter discussed is, of course, no longer new; about half the content of the book is already familiar from the author's similar article in Winterstein's "Handbuch," and other publications; but as a compact, clear, and characteristically vigorous statement of the essential quantitative data upon which the tropism doctrine now rests, the book is welcome and in the main satisfying. In the introductory section it is pointed out that tropistic phenomena, depending upon the orientations of the animal as a whole, rather than the segmental reflexes, must be made the starting point for the analysis of conduct; that these tropistic orientations must first be studied in the behavior of bilateral animals; and that the key to the understanding of tropisms lies in forced movements initiated through differential tensions in symmetrical contractile elements of the body, not in the distinction of "pleasure" from "pain." It is only on such a basis, so far as we know, that quantitative laws may be deduced adequate for the description of behavior. This procedure is illustrated partic-

ularly in the discussion of phototropism, for which the experimental evidence is the most comprehensive.

Doubtless the portion of the book liable to excite the most general interest is that dealing with "Instincts" and "Memory images and tropisms." The author's views on these topics, now well known, are here incisively restated, and on some points extended. It is held that the preservative instincts are tropisms; and that the "problem of free will" is essentially solved through recognition of the orienting influence of memory images—which, being in man multitudinous, render impossible the prediction of individual behavior. The orienting powers of memory images afford an inviting topic for research, and one as yet very inadequately explored.

Two directions in which the results of tropistic analysis are of use to the naturalist are not so fully developed as one might wish: the value of determinate behavior in animals as a starting point for the experimental investigation of irritability, and the significance of the physical viewpoint for the analysis of organic phenomena as actually seen in nature. The limitations of space, however, have compelled great brevity of treatment. Nevertheless, the reader of this book should succeed in gaining fast hold of the conception that mere complexity is no bar to ultimate clarity of understanding in these matters; and should, in addition, acquire a healthy distrust toward the indiscriminate application of "laboratory results" to field conditions. The tropism doctrine, in other words, is in no sense an artificial simplification of "animal behavior." In this connection, specifically, the book will be particularly valuable as an introductory manual for students. To the investigator, already familiar with these ideas (it is to be presumed, but not in all instances correctly), the book has less new material to offer.

A bibliography of some 554 entries, not very well arranged and comprising some repetitions, together with a brief index of two and a quarter pages, complete the book. It is stated, rather bluntly, that the bibliography intentionally excludes "controversial and amateurish publications," and to that extent it should prove a useful guide. The citations are less complete for the years since 1911 than for the preceding period. No attempt has been made to critically discuss the contents of the publications listed, which is in many respects a blessing; for it is as a unitary presentation of the author's views that the monograph will be read with interest by all workers in this field.

W. J. CROZIER

UNIVERSITY OF ILLINOIS,
CHICAGO

THE GEOLOGICAL SOCIETY OF AMERICA

THE thirty-first annual meeting of the Geological Society of America was held in the rooms of the Department of Geology, Johns Hopkins University, Baltimore, Md., on Friday and Saturday, December 27–28, 1918, under the presidency of Dr. Whitman Cross of the United States Geological Survey.

The following program was presented:

Geology as a basis of citizenship: JOSEPH POGUE. (Read by title.)

Sources of and tendencies in American geology: JOSEPH BARRELL.

Geology as a synthetic science: WARREN D. SMITH. (Read by title.)

The United States Geological Survey as a civic institution during the war: SIDNEY PAIGE.

The military contribution of civilian engineers: GEORGE OTIS SMITH.

Presentation of geological information for engineering purposes: T. WAYLAND VAUGHAN.

Engineering geology in and after the war: CHARLES P. BERKEY.

Geology in the Students' Army Training Corps: HERBERT E. GREGORY.

Cooperation in geological instruction: HERBERT E. GREGORY.

Map making, map reading and physiography in the training of men for the army and navy: WALLACE W. ATWOOD.

War work by the department of geology at the University of Oregon: WARREN D. SMITH. (Read by title.)

Recent earthquakes of Porto Rico: HARRY F. REID and STEPHEN W. TABER.

Structure of the Pacific ranges of California: BAILEY WILLIS.

Migration of geo-synclines: AMADEUS W. GRABAU.

Geotectonic adaptation through retardation of the earth's rotation: CHARLES R. KEYES. (Read by title.)

Late Mississippian orogenic movements in North America: FRANCIS M. VAN TUYL and RAYMOND C. MOORE. (Read by title.)

Post-glacial uplift of the New England coastal region: HERMAN L. FAIRCHILD. (Read by title.)

Topographic features of the Hudson Valley and the question of post-glacial marine waters in the Hudson-Champlain Valley: JAMES H. STOLLER.

Subterranean "chalk-streams" of northern France: EDWARD MOORE BURWASH. (Read by title.)

The relative efficiency of normative and modal classifications of igneous rocks: EDWARD B. MATHEWS.

Pegmatite, silexite and aplite dikes of northern New York: WILLIAM J. MILLER.

Magnetic iron ore deposits of Clinton County, New York: WILLIAM J. MILLER.

High grade clays of the United States: H. RIES.

Occurrence and origin of white clays at Saylorsburg, Monroe County, Pa.: F. B. PECK. (Read by title.)

Oil geology in relation to valuation: RALPH ARNOLD. (Read by title.)

Rock products and the war: G. F. LOUGHLIN.

Manganese ore as a war mineral: D. F. HEWETT.

World view of mineral wealth: JOSEPH B. UMPLEBY.

Internationalization of mineral resources: C. K. LEITH.

Commercial control of the mineral resources of the world: JOSIAH E. SPURR.

The economic limits to domestic independence in minerals: GEORGE O. SMITH.

Imperial Mineral Resources Bureau, London, England: WILLET G. MILLER. (Read by title.)

Some problems of international readjustment of mineral supplies as indicated in recent foreign literature: ELEANORA F. BLISS. (Introduced by C. K. Leith.)

War time development of the optical industry: F. E. WRIGHT.

Geologic and present climates: MARSDEN MANSON. (Introduced by E. O. Hovey.) (Read by title.)

Conditions of deposition of some Tertiary petroliferous sediments: AMADEUS W. GRABAU. (Read by title.)

Phosphate rock an economic army: R. W. STONE.

Prevailing stratigraphic relationships of the bedded phosphate deposits of Europe, North Africa and North America: AMADEUS W. GRABAU. (Read by title.)

Principles in the determination of boundaries: A. P. BRIGHAM.

Geographic descriptions of army cantonments and of United States boundary regions: M. R. CAMPBELL. (Read by title.)

The Signal Corps school of meteorology: OLIVER L. FASSIG. (Introduced by N. M. Fenneman.)

The American topographer in the rôle of artillery orientation officer: F. E. MATTHES.

A method of aerial topographic mapping: FRED H. MOFFIT.

Mexican petroleum and the war: E. W. SHAW. (Read by title.)

American mapping in France: GLENN S. SMITH.

Military mapping—a plane table: ALAN BATEMAN. (Read by title.)

The sand chrome deposits of Maryland: JOSEPH T. SINGEWALD, JR.

The Cartersville potash slates, their economic relation to chemical and industrial post-war development: T. POOLE MAYNARD. (Read by title.)

The anticlinal theory as applied to some quicksilver deposits: JOHAN A. UDDEN.

Crystalline graphite deposits of Alabama: WILLIAM F. PROUTY. (Read by title.)

Evidence as to the age of the semi-crystalline and crystalline rocks: WILLIAM F. PROUTY. (Read by title.)

Contributions to the origin of dolomite: W. A. TARR. (Read by title.)

The magnesite industry: R. W. STONE.

Although the number in attendance at the meeting of the society was not as great as at some of the eastern meetings there were about one hundred and twenty-five members and guests registered. The papers presented were interesting and valuable, and the days were crowded with events.

Luncheon was secured each day, together with the American Association for the Advancement of Science and other affiliated societies, in the Machinery Hall of the university.

Friday evening was occupied with the subscription smoker at which was held a round table discussion, presided over by Professor Bailey Willis, on "Cooperation in Geological Instruction" led by Professor Herbert E. Gregory and participated in by Professors George F. Kay, Charles P. Berkey, J. C. Merriam and William M. Davis.

The annual dinner of the society held jointly with the Paleontological Society and the Association of American Geographers was held, under the chairmanship of President Whitman Cross, at the Southern Hotel on the evening of Saturday. Ad-

dresses were made by Professor Merriam, Dr. Henry M. Ami and Professor William M. Davis. The evening was closed with the reading of the presidential address by Dr. Cross, entitled "Geology in the War and After," and followed by the address of the retiring vice-president of Section E of the American Association for the Advancement of Science, George H. Perkins, entitled "Physiography of Vermont."

The officers for the ensuing year, beginning at the close of the Baltimore meeting, are as follows:

President—J. C. Merriam.

Vice-presidents—R. A. Penrose, Jr., Herbert E. Gregory, Robert T. Jackson.

Secretary—Edmund Otis Hovey.

Treasurer—Edward B. Mathews.

Editor—Joseph Stanley-Brown.

Councilors, 1919–1921—William S. Bayley, Eugene W. Shaw.

Edmund Otis Hovey,
Secretary

THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

The tenth annual meeting of the society was held in Gilman Hall, Johns Hopkins University, Baltimore, Md., December 23–28, 1918, in affiliation with the American Association for the Advancement of Science and the Botanical Society of America.

About fifty members were present. The program was devoted chiefly to project conferences and reports of the War Emergency Board, accounts of which will be distributed separately. Sixteen papers were presented at the regular sessions, abstracts of these appeared in the January number of *Phytopathology*. Twenty-nine new members were elected.

Joint sessions were held with Section G of the American Association for the Advancement of Science and also with the Botanical Society of America.

The followng officers were elected:

President—C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

Vice-president—I. E. Melhus, Iowa State College, Ames, Iowa.

Secretary-treasurer—G. R. Lyman, U. S. Department of Agriculture, Washington, D. C.

Councilor for two years—Donald Reddick, Cornell University, Ithaca, New York.

Associate Editors for three years—Geo. L. Peltier, Agricultural Experiment Station, Auburn, Alabama; F. D. Heald, Agricultural Experiment Station, Pullman, Washington; J. E. Howitt, Ontario Agricultural College, Guelph, Ontario, Canada, and J. B. S. Norton, Maryland State College, College Park, Maryland.

Business Manager of Phytopathology—G. R. Lyman.

The society decided to hold its next annual meeting at St. Louis, Mo., in conjunction with the American Association for the Advancement of Science, December 29, 1919, to January 3, 1920.

Besides the papers presented at the War Emergency Board Conferences the following were read Saturday, December 28:

The Physoderma disease of corn: W. W. Tisdale.

Macrosporium solani on tomato fruit: Jos. Rosenbaum.

Notes on the rusts of the Piñon pines: Ellsworth Bethel, N. Rex Hunt.

Hot water seed treatment for blackleg of cabbage: J. B. S. Norton.

Fungi which decay weaveshed roofs (with lantern): R. J. Blair.

Resistance in the American chestnut to the Endothia canker (with lantern): A. H. Graves.

Investigations of white pine blister rust, 1918: Perley Spaulding.

Isolation of fungi from manufactured sugars: Nicholas Kopeloff.

On Wednesday evening, December 25, there was a dinner and a special program in celebration of the tenth anniversary of the organization of the society. The following papers were presented:

Our journal, "Phytopathology": L. R. Jones.

The first decade of the society: C. L. Shear.

The reading of these papers was followed by a general discussion of society problems and relations which proved interesting and valuable.

C. L. Shear,
Secretary-Treasurer

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